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AVIATION AND COSMONAUTICS

Cosmonautics History Reviewed

91440064a Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 10, Oct 87 (signed to press 2 Sep 87) pp 1-3

[Article by Lt Gen Avn G. Titov, HSU, USSR Pilot-Cosmonaut: "Land of October: Motherland of Cosmonautics"]

[Text] The Great October, which opened a up new era in world history, an era of revolutionary renewal of the world, also made a path to mankind's space future. Just four decades separate the launch of the first artificial earth satellite from the Great October Socialist Revolution. In this short segment of time, a backward Russia developed into a powerful industrial state with a high level of science and technology.

In May 1919 a letter was received in V. I. Lenin's secretariat from chemical engineer N. I. Tikhomirov. Tikhomirov's suggestion for creating a rocket projectile might appear strange, to put it mildly, at that difficult timd and conventional arms. Nevertheless, it was examined and approved by the Inventions Committee and the Artillery Committee.

In 1921 Tikhomirov was assigned a house on Tikhvinskaya ulitsa in Moscow as a laboratory. Seven years later came the first launch of a rocket using smokeless powder. The laboratory was expanded and transferred to Leningrad nearer the range. It also received a new name, the Gas Dynamics Laboratory (GDL). That was the origin of the first organization in our country to mark the beginning of the development of an indigenous industry for creating rocket and space technology.

During those same years in quiet, provincial Kaluga not far from the capital schoolteacher K. E. Tsiolkovskiy continued to develop ideas of studying outer space. The Great October, which provided the foundation for a new socialist life and for the progress of science, technology and culture, also did not ignore the solitary scientists. The person who not very long before was called a "somewhat eccentric dreamer" became a scientist with a world name under Soviet power.

Now life gained specific meaning for Konstantin Eduardovich: to work for the good of the young Soviet Republic and be a useful member of it. Tsiolkovskiy's contribution to the development of cosmonautics theory is enormous. This remarkable person also performed a great service in shaping the views of pioneers of Soviet rocket building. They often turned to the forefather of cosmonautics in search of organizational forms, and he invariably would respond and help them with advice.

M. K. Tikhonravov, a prominent Soviet designer of rocket and space technology, called F. A. Tsander, the centennial of whose birth was celebrated by our country this year, the first space engineer. In addition to developing a theory of interplanetary flight, Tsander was first among enthusiasts to begin designing and creating rockets and rocket engines.

Yu. V. Kondratyuk passed through the sky of cosmonautics like a meteor. Back in the 1920's he examined many principles of manned flight in the manuscript "Tem, kto budet chitat, chtoby stroit" [For Those Who Will Read in Order to Build].

Daring ideas on interplanetary flight harmoniously combined with the people's enthusiasm. Pioneers of cosmonautics for the first time felt the joy of creativity, and this lent them wings, inspired them, and forced them to work without thought of bonuses or days off. They were creators who did not betray the dream throughout their lives.

The Society for the Study of Interplanetary Travel was organized in Moscow in May 1924. It took a serious step in unifying the efforts of many scientists, engineers and designers who were dreaming of space flight. Its experience was used subsequently in establishing the Group for the Study of Jet Propulsion (GIRD) under Osoaviakhim [Society for Assistance to Defense and Aviation-Chemical Construction of the USSR] in Moscow, Leningrad, Tbilisi, Baku, Orenburg, Arkhangelsk and other cities.

The Moscow group led by S. P. Korolev was highly successful. The first Soviet liquid-propellant rockets were created and tested at Nakhabino near Moscow, and enthusiasts in Leningrad designed the first solid-propellant rockets literally in a year's time. Professor N. A. Rynin of the Leningrad Institute of Railways, a well-known pedagog who left a noticeable imprint on the history of cosmonautics by publishing the first encyclopedia "Mezhplanetnyye soobshcheniya" [Interplanetary Travel], was a member of the presidium of the Leningrad Group for the Study of Jet Propulsion.

Successes of the Gas Dynamics Laboratory and the Moscow Group for the Study of Jet Propulsion promoted a further improvement in work on rocket technology. By decree of the Labor and Defense Council the world's first Scientific Research Institute of Jet Propulsion (RNII) was established in the fall of 1933. Prominent state figures K. Ye. Voroshilov, G. K. Ordzhonikidze and M. N. Tukhachevskiy worked on setting it up.

The great romantics and pioneers of Soviet cosmonautics also were great realists. Fascism was crawling across Europe like a cancerous tumor and there was no more important task for associates of the new organization than that obligating them to work on weapons to defend the Motherland. The first rocket projectiles they developed appeared on warplanes. Pilots of militarist Japan felt their power in 1939. But the Scientific Research Institute of Jet Propulsion made the greatest contribution to national defense by creating the legendary Katyushas.

Work went on in parallel in the Institute on liquid-propellant and winged rockets. Under the direction of V. P. Glushko, several tens of ZhRD [liquid-fuel rocket engines] were created in those years. The ORM-65 engine became the best domestic engine of its time. In February 1940 pilot V. P. Fedorov flew for 110 seconds in the SK-9 glider designed by Korolev with the RDA-1-150 liquid-fuel rocket engine. The "604" ballistic rocket with a 20 km radius of action also appeared in that same year. And who knows how things would have gone in this direction in the Scientific Research Institute of Jet Propulsion had it not been for the war.

State tests of the first ground rocket launchers had taken place on the eve of fascist Germany's treacherous attack on our country. On 14 July 1941 the first seven Katyushas commanded by Capt I. A. Flerov launched 112 projectiles which came down on the enemy with incinerating fire. That day became the birthday of Soviet rocket artillery. On 15 May 1942 test pilot G. Ya. Bakhchivandzhi took up the first domestic interceptor aircraft, the BI-1 with a liquid-fuel rocket engine created by A. Ya. Bereznyak and A. M. Isayev in V. F. Bolkhovitinov's KB [design bureau].

Neither of these events seemingly has any direct relationship to the history of cosmonautics, but they help trace how ideas of jet propulsion had seized the minds of scientists and how tests were made on the ground and in the air, bringing us closer to the space era step by step.

World War II died away, but things did not become calmer on the planet. Ruling circles of the United States and Great Britain followed a policy of aggravating the international situation and took the path of preparing for war against the Soviet Union. These plans of imperialism had to be disrupted.

Sagaciously evaluating the capabilities and prospects of rocket technology, the Communist Party and Soviet government assigned scientists the task of creating a reliable nuclear missile shield. S. P. Korolev was appointed Chief Designer of Long-Range Ballistic Missiles. Intensive developments of nuclear weapons were carried out under the direction of I. V. Kurchatov.

The first domestic missile system with R-1 guided ballistic missiles underwent tests in the fall of 1948. A year later tests began of the R-2 missile with a separating re-entry vehicle. The first strategic missile, the R-5, was created in 1953 and the first intercontinental missile was launched in August 1957.

Successes of the Land of Soviets in creating a nuclear missile shield extinguished for a long while the flame of a new war which had been about to flare up, and the launch of the first artificial earth satellite which followed right after the launch of the intercontinental missile spread confusion in the camp of our enemies.

Creation of the first satellite demonstrated the level of development of industry and transport and the capacity of the entire USSR national economy. The fact is that only countries with developed technology and possessing a high industrial potential were capable of accomplishing space research tasks, and our Motherland became the first among them. At 2228 hours Moscow time on 4 October 1957 she opened up a new era for mankind, this time a space era.

The Soviet people are rightly proud of achievements in the field of cosmonautics. They are also proud of the glorious sons of the homeland whose utter dedication to their job made it possible to open up the space era. Korolev and M. V. Keldysh became the generators of new ideas in the science and technology of space flights and immediate participants in their implementation. They were the ones who laid down and developed scientific, engineering and organizational principles of practical Soviet cosmonautics. We also pay a tribute of respect to their closest companions-in-arms M. K. Yangel, V. N. Chelomey, V. P. Glushko, N. A. Pilyugin, V. P. Barmin, V. I. Kuznetsov, M. S. Ryazanskiy, G. N. Babakin and A. M. Isayev, who made a great contribution to the establishment and development of our rocket and space technology.

Thirty years have gone by from the moment the first satellite was launched. Now more than 120 states are following directly or indirectly behind the Soviet Union, pioneer of space development, taking advantage of the results of practical cosmonautics in the interests of economy, science, education and culture. Far-flung space systems with a varying specific purpose and multifunctional gear have come to replace individual satellites.

A new phase in development of rocket and space technology was opened in the year of the 70th anniversary of the Great October: on 15 May flight-design tests began of the powerful Energiya general-purpose delivery vehicle intended for placing both reusable orbital craft as well as large spacecraft for scientific and national economic purposes into near-earth orbits.

This does not mean that the Soviet Union is rejecting the reliable Kosmos, Soyuz, Molniya and Proton boosters that have given a good account of themselves. An optimum combination of different classes of delivery vehicles, spacecraft, interorbital tow vehicles and other space technology will permit establishing a highly efficient Earth-Space-Earth transport bridge.

The appearance and make-up of space flight support services have changed beyond recognition during these years. Spacecraft no longer are launched just from Baykonur, but from three cosmodromes in the Soviet Union. Simulator systems have come to replace individual stands and simulators in the Cosmonaut Training Center imeni Yu. A. Gagarin. The network of command and measurement points with flight control centers also has

expanded. The "star flotilla" (vessels providing control of the spacecraft and reception of data from them) headed by the flagship, the vessel "Kosmonavt Yuriy Gagarin," has been supplemented. The scale of tasks now being accomplished has grown so much that hundreds of different organizations take part in implementing them.

Continuously stimulated by requirements for its application in various fields of science, economics and culture, the development of cosmonautics is called upon to play an even more important role in the future in resolving such pressing problems as food, raw materials, energy and ecology.

Cosmonautics today can be viewed as a field of new technology which can serve as an example for all sectors of the national economy.

Speaking in May of this year to representatives of labor collectives of the city of Leninsk at Baykonur, Comrade M. S. Gorbachev said: "Here in the boundless steppe of Kazakhstan one senses a feeling of pride in the intelligence and accomplishments of Soviet citizens and in our Soviet homeland. Here one senses more strongly the majesty and might of the country of October and its enormous achievements which crown the 70-year path of peoples of our great multinational state following the October Socialist Revolution."

The example is indicative especially in the present period when, in implementing resolutions of the 27th CPSU Congress, Soviet society has set a course toward restructuring and has risen up to accomplish new tasks which are impossible to cope with by old methods. The experience of cosmonautics persuades us and inspires confidence that Soviet citizens are capable of the grandiose plans of revolutionary restructuring outlined by our party.

Radio communications is the most developed field of practical application of space technology: radio broadcasting, television, telephone and telegraph traffic and facsimile images. The task of covering USSR territory with two-program television essentially has been resolved with the help of Molniya, Raduga, Ekran and Gorizont series satellites; television programs are being broadcast in five zones with consideration of local time. The Intersputnik system has been solidly serving peoples of socialist countries for more than 15 years now. Now not only residents of populated points, but also mobile groups—geologists, builders, seafarers—have an opportunity to watch Central Television broadcasts. Small receivers contribute to this. Satellite communications with the transmission of photocopies of central newspapers for publication simultaneous with Moscow in cities spread out over eight time zones has become widespread.

Meteorologists are making a substantial contribution toward the accomplishment of national economic tasks, and the Food Program above all. USSR Gidromettsentr [Hydrometeorological Scientific Research Center] forecasts (data from Meteor satellites also are used in their compilation) permit giving advance warning to agricultural workers about weather changes and devastating atmospheric phenomena, enabling necessary measures of protection to be taken promptly. Data from these satellites help the navigation and aviation operations service to select or update optimal safe routes for vessels and aircraft.

The study of the Earth's natural resources from space is acquiring more and more practical significance for development of the economy. Space data help to accomplish tasks of geological exploration, to create maps for various purposes, to evaluate the condition of natural lands and inventory them, to select routes for running high-voltage power lines and main transport lines in areas difficult of access, and to perform effective monitoring of the status of reservoirs and the air basin and search for areas of increased biological productivity of seas and oceans. A space geological map of the USSR at a scale of 1:2,500,000 has been compiled using space resources. More than 500 areas in Central Asia, Kazakhstan and Yakutiya which show promise for the presence of minerals were identified and passed on for prospecting based on data of space observations.

Space navigation systems designed for determining the position of vessels of the Soviet Union's maritime and fishing fleet at any point in the ocean find wide use today. Because of its global, prompt and highly accurate nature, navigation position finding with the help of satellites improves navigation safety, reduces running time and fuel consumption, and improves the efficiency of the fishing fleet. Satellite navigation systems also are used in the interests of oceanography and geophysics, in oil production operations in shelf areas, and in measuring ice drift.

Manned cosmonautics has taken strides from the 108 minutes of Yuriy Gagarin to the 237 days of Leonid Kizim, Vladimir Solovyev and Oleg Atkov, and from the Vostok spacecraft-satellite to the Mir multipurpose orbital scientific complex. Here are a few figures which provide a graphic impression of the strides of manned cosmonautics. Cosmonauts flew around 15 days aboard the Vostoks, 637 days aboard the Soyuzes, and 1,029 days aboard the Soyuz T's. The Soyuz dynasty was continued by the Soyuz TM craft. The orbital watch of Soviet cosmonauts, who made an enormous contribution to the cause of world space development, has lasted more than four years overall.

Soviet cosmonautics achieved major results in the study of the Moon and planets of the solar system. Fifty-seven automatic stations of different types were created and launched in the Soviet Union in these years. Studies performed with their help substantially broadened mankind's understanding of the surrounding world and of processes occurring on Earth and became the basis for a new science, comparative planetology.

The development of outer space is a far from simple matter. It demands an extraordinary intensity of effort and highly developed scientific and technical potential. This is why from the very beginning of the space era the Soviet Union came out resolutely in favor of and still favors a unification of efforts and the cooperation of all states in use of outer space.

For more than two decades the USSR has been participating in programs of international cooperation to develop outer space. A number of agreements have been concluded at its initiative among countries of the socialist community, which in April of this year celebrated the 20th anniversary of joint activities in this direction.

Within the framework of the program of fraternal countries 23 Interkosmos series satellites, 11 Vertikal high-altitude rockets and hundreds of meteorological rockets have been launched. Results of these studies became the property of all partners. The collaboration of socialist countries is constantly expanding. Representatives of the CSSR, Polish People's Republic, GDR, People's Republic of Bulgaria, Hungarian People's Republic, SRV, Mongolian People's Republic, Cuba and the Socialist Republic of Romania made space flights together with Soviet cosmonauts during 1978-1981. They performed some 150 scientific-technical experiments and studies.

The Soviet Union cooperates with other countries in this important field of human endeavor both on the basis of bilateral agreements and on a multilateral basis. Examples of this are the joint Soviet-American Apollo-Soyuz Test Project in 1975 and flights of Soviet-French (1982) and Soviet-Indian (1984) crews aboard Soviet space equipment. The flight of a Soviet-Syrian crew is a recent example of our country's good will. The KOSPAS-SARSAT satellite system intended for determining the position of vessels and aircraft in distress is functioning successfully on a multilateral basis.

True to its traditions of developing international cooperation in the field of space development, the Soviet Union has been working out a widescale program with other countries for the peaceful study of outer space over the next few years and over the long term. For example, joint flights are planned for cosmonauts of the USSR and Bulgaria, USSR and France, USSR and Afghanistan, and USSR and Austria. An Indian satellite and Soviet Granat satellite with the French Sigma gamma-ray telescope installed on it will be launched from the Baykonur Cosmodrome. It is also planned to lauch two spacecraft for studying distant space objects in the Phobos Project, in which specialists of 11 countries and of the European Space Agency are participating. We thereby are setting an actual vivid example of the possibility of studying and using space exclusively for peaceful purposes through joint efforts of states for the good of peoples.

Today our country proposes to create an international center with the help of leading space powers for research and development of models of space equipment based on orders of developing countries in which there would be a school for training specialists from developing countries, including cosmonauts, as well as a cosmodrome for launching space objects.

The Soviet Union attaches great significance to the idea advanced in this program for instituting a world space organization which would help elevate international cooperation in the peaceful development of space to a qualitatively new and higher level. The intent is to carry out international projects in various fields of space science and applied cosmonautics under the aegis of this organization.

The 27th CPSU Congress gave special attention to ensure that outer space does not become an arena of military rivalry or a source of death and destruction. Soviet foreign policy initiatives are designed to ensure that mankind greets the new age under a peaceful sky. We are countering "star wars" with "star peace" and with broad cooperation of peoples in the peaceful development of outer space.

Peaceful reason must win. All honest people of the planet for whom the concept "Earth," "space," and "peace" are indivisible believe this.

6904

Stress on Preventive Work in Flight Safety

91440064b Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 10, Oct 87 (signed to press 2 Sep 87) pp 4-5

[Article by Mar Avn P. Kirsanov, chief of USSR Armed Forces Central Flight Safety Inspectorate, under rubric "Flight Safety: Experience, Analysis, Problems": "Make Prevention Highly Effective"]

[Text] The combat training of military aviators has entered the final phase in the jubilee year. The majority of units and subunits achieved good results in various kinds of combat training by ensuring accident free flight operations. Guided by the requirements of governing documents and making a principled assessment of the effectiveness of measures to prevent flying incidents and their preconditions, commanders and political officers organize and conduct flight sections with the guaranteed exclusion of dangerous situations in the air through the personnel's fault. That is just how matters stand in the air regiments where Gds Lt Col V. Zuzlov, Capt Yu. Zinchenko and others serve.

Meanwhile some collectives unfortunately still make mistakes leading to flying incidents, which are a heavy burden on all aspects of the personnel's life and work. The precise, adjusted rhythm of combat training is thrown off and the people's activeness drops.

An entire set of measures of a directive, organizational, methods, and research nature serves to prevent accidents in air units and subunits. A significant portion of the functional duties of commanders, political officers and the officers of staffs and services also is directed toward preventing accidents. Measures ensuring flight safety are generalized annually in organizational instructions with consideration for the specifics of different air arms and are invariably reflected in a special section of each unit's annual combat training plan. Information on deficiencies in flight operations uncovered during inspections of aviators' combat training is provided along with an accounting and analysis of the deficiencies. This is one of the basic duties of officers of authorized flight safety services. There is an objective discussion of the above issues at special sessions and conferences of leadership personnel and at periodic assemblies and practical science conferences.

Just why are the end results of the prevention of flying incidents and their preconditions not always high despite such considerable efforts?

Experience indicates that in a number of cases the insufficient effectiveness of this work is explained by one and the same omissions. The most widespread omissions are an oversimplified impression of the causality of accidents in contemporary aviation and formalism in planning and conducting measures to prevent all possible mistakes on the ground and in the air.

Such an approach to the cause and effect relationships of accidents cannot of course reveal their complex nature fully enough. The fact is that essentially every flying incident today occurs not for one reason, as is sometimes stated, but as a result of the sum of several miscalculations and infractions by specialists of various services.

There is no question that a "single cause" considerably simplifies the course of investigations, determining culprits and working up summary documents on the incident. But then other original causes usually lying on the surface and relating not only to actions of pilot and crew but also to the organization and support of flights, control of flights, accepted training methodology and reliability of equipment go unidentified and so are not eliminated. With an unfavorable confluence of circumstances, they are what can lead to the appearance and development of emergency situations over and over again.

Unfortunately formalism took root in many elements of preventive work, undermining its primary purpose of preventing a recurrence of the most typical and most likely incidents for given conditions and content of flight training. It is most often manifested in the form of an extreme narrowing and limiting of the base of analysis—that volume of statistics based on which an assessment of the local state of affairs is made and a plan of preventive measures is formed.

Another very widespread element is the choice and planning of preventive measures themselves. It should be admitted that in some units these plans do not attain the desired objective and have turned into "accounting documents." This is all because, like the leaders who approved them, their "developers" put little thought into the reality of fulfilling the measures they contain. They often do not reflect the true status of flight safety with consideration of missions being accomplished by the aviators and they are not coordinated by time with other conditions as well.

The time has come to resolutely reject the accumulation of dozens of empty paragraphs often rewritten from document to document. Commanders and other officials have no right to ignore such formalism in examining draft plans supporting flight safety. This is especially necessary now when documentation for the new training year has begun to be worked up. Elaboration of such a plan must begin without fail with an evaluation of the effectiveness of its predecessor, the plan for the year which has ended. With no specific answer to the question of whether or not that plan influenced an improvement in flight safety for the period in which it was in force, the comrades who do the planning reduce their work, like it or not, to a formal selection of contrived measures.

And finally the very practice of daily preventive work in the unit and subunit requires the most fundamental elimination of formalism. Having absorbed the aforementioned deficiencies of analyzing the status of flight safety and the deficiencies of planning the activities supporting flight safety, this work often is done not so much to improve the personnel's actual knowledge and skills in preventing accidents as for a primitively understood execution and accountability: We did it; it is marked "done."

By the way, representatives of higher staffs and of various commissions also contribute to the tenacity of such a bureaucratic approach when after arriving in the unit they focus efforts only on accountability and a review of documentation without even getting down to lively contact with flight and engineering-technical personnel and without appearing at the airfield, at equipment preparation positions, or at flight control points.

Where formalism leads in questions of flight safety is apparent just from the following example. Recently it was learned that pilots in some units are passively using automated devices and systems specially designed for guaranteed assurance of flight safety, and in its responsible areas above all. These are various warning devices (lights, signal panels, bells, buzzers and even spoken messages) which are triggered by a descent to a given flight altitude, a reduction in engine power settings, or a dangerous approach to another aircraft in flight, as well as devices which automatically maintain a given altitude

and other flight parameters right up to giving active resistance to the pilot on the controls when the aircraft approaches an established restriction or dangerous regime.

Nothing would seem simpler: use existing "intelligent" equipment as prescribed and it will prompt you on necessary actions in the most important sector of the flight. Nevertheless, several incidents occurred where pilots either did not switch on such devices at all or did not react to a warning signal which was clearly registered both on the flight recorder tape and on a tape recorder. There were similar infractions in these units before, but none of the commanders genuinely reacted to them. It was no accident that the plans for flight safety measures here did not reflect the flyers' mastery of such devices and the methodology of their most rational use in various stages of flight.

A special role is played by two categories of aviators among appointed persons who have an opportunity to influence flight safety. On the one hand they are the leaders of the air unit, and its commander above all, and on the other hand, it is the pilot himself who makes the flight, no matter what position he holds and no matter what type of aircraft he flies. Experience shows that it is these categories of aviators who far from always make full use of their opportunities to prevent flying incidents. At the same time they are the ones for whom the most optimal conditions must be created for performing their duties. It is of course not a question of creating some kind of hothouse conditions or a situation of oversimplification, but of the inadmissibility of petty coddling or separating them from performing urgent tasks, let alone constant dressings-down, including in the period of flights.

In organizing the personnel's work in all basic elements of combat training, discipline and order, the regimental commander must clearly realize that the state of affairs involving flight safety will depend very directly on his personal attitude toward this matter: principled or formal, thorough or superficial.

The organization of prevention of flying incidents and immediate personal participation in such prevention represents another very important direction in the regimental commander's work in the interests of having no accidents. The forms of prevention themselves are difficult for many officer leaders in this matter. In fact the tasks, objectives and principles of prevention are described in sufficient detail, but the majority of directions and elaborations mention the practical aspect of this matter basically in a general form—perform preventive work persistently—with no specific recommendations on just what methods to use.

The best air units conduct such prevention using those forms which reflect the content of combat training and political indoctrination work. These include all kinds of classes and checks of knowledge, practice sessions on aviation equipment and simulators, special flights to practice specific skills in actions in special instances, as well as disciplinary practice concerning violators of flying laws. But these customary forms too are redistributed within the rigid time limit of the "training-flights-flight critique-command training" work cycle in the interests of preventing the incidents most likely to occur in a given period of flights.

The activities which are primarily prepared and conducted are those which on the one hand are most needed right now based on an analysis of the actual flight safety situation and, on the other hand, which are most advisable based on real capabilities existing in the air regiment at the given moment. The fact is that even an interruption or temporary suspension of flights (which unquestionably is one of the extreme preventive measures) sometimes may be advisable and even necessary in a specific situation which the commander who makes the decision must evaluate.

The regimental commander's personal participation in preventive measures is of great importance for the effectiveness of prevention. The benefit will be obvious if for example prior to mastering flights at extremely low altitude he himself holds a well prepared class on the procedure for calculating and maintaining a safe altitude and on comprehensive use of altimeters having a varying principle of action, backing up what is said with one or two examples of the consequences of mistakes in reading altitude.

A commander's critique of infractions identified from the SOK [objective monitoring equipment] for previous flight sections and, if necessary, even a strict suggestion to pilots who have had a recurrence of such deviations will be no less effective prior to advanced flying activities. It is only necessary that the commander's objectivity and lack of bias are without question both for the violators and for the remaining flight personnel.

One other necessary condition for an air commander's effective influence on flight safety is his personal example in complying with flying laws. Not even the sternest dressings-down of violators of flight discipline will be genuinely effective if the commander does not set the example in complying with flying rules, to put it mildly. The gap between word and deed here is especially inadmissible.

The pilot and crew commander is the other very important figure on whom the prevention of flying incidents depends to an enormous extent. Combining within himself the need for precise fulfillment of the flight assignment with the requirement for safety of its completion, it is he who keeps (or does not keep) himself from getting into a dangerous situation and takes (or does not take) all necessary steps to localize it if it nevertheless occurs in the air.

Experience indicates that the majority of deficiencies can be localized espe ially at their inception by a trained, composed pilot with initiative, beginning with his personal decision for the sortie and ending with timely abandonment of an aircraft in trouble. But that level of preventive training does not come of itself; it is the result of extensive work and constant improvement of flight proficiency, which some pilots unfortunately lack.

Professional alertness based on a profound and, no less important, systematically maintained level of knowledge and skills repeatedly allowed combat pilots both during the Great Patriotic War and in our time not only to come out the winners from the most difficult situations, but also not to fall into them through their own mistakes.

The work of ensuring flight safety brooks no stereotypes. Life experience shows that aviators' uniform repetition of one and the same requirements of guidance documents (and often only an enumeration of their names and numbers) does not produce the desired effect. The time obviously has come to combine such work with a differentiated approach to various personnel categories and with the assignment of flight safety tasks corresponding to the personnel's abilities.

Thus it is hardly advisable to formulate a flight safety task for the year using an identical wording for the command element of an air unit and for rank-and-file pilots. A different approach to this will permit the regimental commander and squadron commander to comply with flight safety requirements and will allow those who evaluate flight safety in the regiment to get away from a primitive comparison of the number of preconditions committed.

It also may turn out to be advisable (for directly influencing flight personnel) to analyze flying incidents not only to correlate the proportion of their causes (such-and-such a percentage representing deficiencies of organization and leadership and such-and-such a percentage errors in flying techniques), but also to examine typical kinds of flying incidents themselves which are most specific for each air arm: stalling in flight; collision with terrain; flying incidents at take-off, in the landing and so on. As was stated, there are several reasons comprising the basis of each of them. Therefore any appointed person has to see his opportunity of preventing a dangerous situation and the pilot or crew has to see all the dynamics of its development, from external factors (errors of other persons and equipment malfunctions) to his own actions which parry them. It is an examination of such "models" of flying incidents in combination with requirements of the NPP [Flight Procedures Manual] and RLE [Flight Operations Manual] that can liven up practical prevention and reduce the recurrence of identical flying incidents.

Research organizations and flight safety services where both statistics and suggestions from the troops are concentrated should make a more active search for new approaches to an analysis of flight safety with the objective of producing measures that are not simply effective but above all practically realistic and at the same time sufficiently prompt and that could lead to a reduction in the accident rate not only in the future, but also over the short term.

Resolute rejection of obsolete methods and a search for nontraditional ways of improving flight safety will ensure Air Forces units and subunits with a further increase in combat readiness along with an improvement in the organization of their training. This will be a practical contribution to the job of restructuring, the need for which is understood and sincerely supported by every military aviator.

6904

Improving Methods of Grading Tactical Flight Training

91440064c Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 10, Oct 87 (signed to press 2 Sep 87) pp 6-7

[Article by Maj I. Petrakov, 1st Class military pilot, under rubric "For High Combat Readiness": "Hues of a Good Grade"]

[Text] During a tactical flying exercise the squadron headed by Maj A. Cherevko was assigned a mission of delivering two strikes against an "enemy" airfield: one at night and the other during the day. The night strike presented no special difficulties. A flow of aircraft was supposed to hit targets illuminated from the ground. The daytime sortie was another matter. It was planned to have several groups make a strike from different directions, then a make repeat pass at the target with different headings. The tactical situation did not shape up to be simple. Powerful air defense weapons were located along the route, especially on the approach to the air base, and so the assignment had to be performed under a rigid shortage of time.

This left an imprint on the aviators' preparation for the flights. The pilots tried to make a comprehensive study of the tactical and air situation in the given quadrant, they looked for the most optimum methods of penetrating the air defense, and they practiced different kinds of maneuvering and methods of coordination. Preliminary preparation was saturated with difficult and unexpected narrative problems by which Maj Cherevko tried to bring the simulated situations as close as possible to those of combat. It seemed everything had been considered down to trivial details.

When the tactical flying exercise ended it was learned that the crews had performed advanced bombing against the airfield during the day excellenty. The subordinates of flight commanders captains F. Volya, A. Gerasimov

and A. Kedrov hit the targets in sniperlike fashion using an effective maneuver requiring high pilot training. It was quite natural that the squadron received an outstanding grade for this sortie.

But results of the night group flight pleased neither the commander nor the pilots themselves, who barely kept within a satisfactory norm. The fact that all attention had been given to the daytime exercise in preparing for the LTU [tactical flying exercise] and the nighttime exercise was regarded as simpler was the reason for the failure. Retribution came immediately.

Nevertheless, despite the obvious failure, the aviators did not reproach themselves for it very strongly. The subunit was given an overall good grade for the exercise. But let us ask the question: Just what was the quality of this grade of four? To what extent does it reflect the flight personnel's real training? It would appear that an averaged grade for aviator actions in a tactical flying exercise is far from always rightful.

I am deeply convinced that the work of crews should be graded only by the yardstick of real combat, without any indulgences. The fact is that had Maj Cherevko's subordinates acted in a combat situation, serious losses would have been inevitable and the mission might not have been executed. So did we rightfully receive a four for the exercise? I think the answer is obvious.

How is an averaged grade of aviator actions in a tactical flying exercise harmful? Above all for the fact that it does not permit clearly seeing the real state of affairs in a collective. Moreover, it promotes a glossing over of deficiencies and acute problems and generates an illusion of well-being. This in turn contributes to the appearance of self-complacency in a certain portion of the people and dulls their keenness in perceiving deficiencies in the work. It is no secret that at times these "generalized" fours are earned for the subunit by a group of strong pilots demonstrating outstanding results in tactical application while the so-called "average" persons get by with threes behind the backs of the leaders. Hence the unjustifiably slow growth of some subunits' combat readiness.

Meanwhile there are enough unresolved problems and unused reserves in the process of daily training. For example, the efficiency of flight sections in our squadron is low for now, which is shown if only by the following fact.

At the range it is required that 1st Class pilots attack targets with the first pass and perform subsequent attacks with a change in weapon variant. Inasmuch as the load on the range is high we have an opportunity of making a maximum of three passes. And so it is throughout the year. As a result, training in holding the aiming mark on a target in a real flight is poor, and the fact is that the quality of tactical application depends largely on these skills.

At one time I had occasion to take part in an interesting flying experiment. Pilots were allowed to fly for tactical application if their error in holding the aiming mark on a target was no more than two one-thousandths. I admit that in order to achieve such indicators it was necessary to make five flights each with a camera gun, and on each flight 10-12 attacks were practiced against ground targets. My average points for tactical application at that time were 4.7. Now, unfortunately, that result is gone inasmuch as one of the main ways to improve results and effectiveness of tactical application has been closed by the control barrier of the range mess.

One other example indicates the need for such flights. We usually have to operate against ground targets in pairs and flights. Many years of observation show that results of hitting targets in solo flights are lower for wingmen than for leaders. This is explained best by the specifics of the wingman's attention allocation between the position of the lead aircraft and the target. These specifics subsequently also affect actions during solo attacks on targets. Accustomed to copy leaders, wingmen are unable to maintain flight parameters precisely on their own and they make more mistakes in constructing maneuvers and on the bombing run.

To the question of how to improve the effectiveness of tactical application, 1st Class Military Pilot and Squadron Commander Maj A. Gorlenko responded:

"By compiling a planning table for the flight section I try to take account of subordinates' training, interruptions in flights for tactical application, and previous results demonstrated by the pilots. True, this is not always successful. The fact is that we often have to fly in groups. We rarely go alone to the range, and this affects wingmen's tactical application in less than the best manner although many of them are highly rated pilots."

This results in a paradox: the most stable indicators in tactical application in the squadron are with Capt M. Lopatin's youthful flight. Everything is explained quite simply. During the year the young pilots were preparing to take tests for a class rating. Naturally, more attention was given to the quality of their preparation for solo flights, hence the high indicators.

We can boldly include incomplete work in generalizing and disseminating the experience of socialist competition leaders as well as low validity of data on tactical application coming from the range among the unused reserves for improving crew training. Here is the opinion of Maj V. Dmitriyev, senior navigator of the regiment and a 1st Class military pilot, on this score:

"I often have occasion to direct flights at the range. An analysis of tactical application shows that stable results are achieved by pilots majors Buravtsev, Koporin, Yagodzinskiy and Shelegeda and captains Gorbunov and Chistyak, but there are pilots for whom the average

bombing grade is very low for now. These are captains Kochetkov, Demin, Sharshin, Ignatyev and Malyshev. The fact is, however, that their class rating is the very same as for the leaders!"

Also troubling is the fact that while greatly outstripping their comrades in proficiency, the outstanding persons do not always share experience with them. It is obviously high time for both the regimental command element and the party committee to think about this. Everything new, foremost and progressive in the preparation of the best pilots for flights must be assembled bit by bit and made the property of all crews without delay.

I am convinced that the most dangerous thing in flight work is indifference. Sad as it may be, we do have officers who have little interest in the results of their work. I would like to place Flight Commander Capt A. Gerasimov as an example for them. He analyzes in a most thorough manner not only those flights in which subordinates make mistakes, but also those for which they receive outstanding marks and takes note of the slightest inaccuracies in the pilots' actions. What does this provide? Above all it permits preventing serious mistakes. For now, however, no one has worked on generalizing his experience.

I also cannot fail to mention that great moral damage is done by lack of objectivity of grades given at one of our ranges. Intersections of ammunition impact points are made there very, very approximately and no time is allocated for inspection of targets due to the high intensity of flights. Such criticism has been repeatedly entered in the log of range preparation for flights, but it is still the same old story, as the saying goes. This leads to a situation where pilots fly to this range without any particular desire or effort, knowing in advance that grades will be exaggerated.

In addition, advanced tactical assignments are rarely practiced during daily flights, and so it happens that some crews begin to make mistakes as soon as the situation becomes complicated in a tactical flying exercise. It is all because their tactical thinking lags behind today's demands.

Maj V. Balabko, the regiment's engineer for PRNK [sighting-navigation system], says: "I consider purposeful work to maintain given accuracy characteristics of the sighting and navigation system to be an important direction for improving the effectiveness of tactical application. But here is where many problems arise for us. Some of them again are connected with deficiencies at the range, as already mentioned, but there are also others. We still have many complaints about the quality of expendable material coming into the unit. For example, the condition of film used in photo monitoring instruments is such that we can more or less accurately determine that the aiming mark was held on the target in one flight out of three, and the photo monitoring instrument itself is far from perfect and became obsolete long ago.

"But it is not just objective reasons that hamper us. Unfortunately not all specialists try to achieve high effectiveness of tactical application. It is not just a matter of unconscientiousness here. Let's look into which of the IAS [aviation engineering service] representatives is responsible for what. Bombing results concern the aircraft technician little. The important thing for him is that the engine and aircraft systems function reliably. The armament specialists are concerned only with ensuring that no ammunition is brought back through their fault. Specialists of the sighting-navigation system group are interested basically in serviceability of the sight and not where bombs or projectiles fall.

"And so it turns out," concludes Officer Balabko, "that only the regimental navigator, chief of VOTP [not further identified], and engineer for the sighting-navigation system have to work on solving the problem. With that approach to an important and complicated matter can we really move it from dead center? No. We have to have what is called the vital interest of all specialists in the end result of the entire collective's work. And that is what I consider tactical application to be."

It is impossible not to agree with Maj Balabko's opinion. The following incident persuades one of the correctness of his words. On the eve of the tactical flying exercise one of the units in the sighting-navigation system was replaced aboard the aircraft of Maj N. Malinkin, a 1st Class military pilot, after which it was necessary to align the aircraft without fail. But Sr Lt A. Gravin, chief of the sighting-navigation system group, referred to a lack of time and did not do this.

The pilot took off for three flight sections in a row, performing assignments under the tactical flying exercise plan. As a result several twos appeared in his flight log inasmuch as he could not hit the target through Sr Lt Gravin's fault. The large amount of material resources essentially cast to the wind and the moral damage done to the pilot generally are impossible to evaluate. This is the price of irresponsibility!

I also cannot skirt the following problem. One of the indicators for fulfilling the annual plan continues to be the number and not quality of bombings. Because of this not one pilot was removed from flying during the year for poor indicators in tactical application. And so from section to section untrained crews uselessly shake the air at the range with explosions although after the very first failure there should have been a detailed examination of its causes and the aviators should have been helped to remedy mistakes. If the equipment was at fault it should have been placed in order. Do we really have the right to take such a wasteful attitude toward state resources?

It cannot be said that our collective is not fighting the deficiencies. The subunits are doing much to get rid of them. For example, lately the materials of objective monitoring equipment have been used more and more in the training process. We do the following in particular. We take a few test graphs of flights and make copies from them of those sectors depicting the maneuver against the target and the attack. A graphic picture is obtained of how optimal parameters of a flight for tactical application are maintained.

Or take another example. We make photographs from the film of photo monitors on which the position of the mark relative to the target is registered. For greater instructiveness we glue to the photographs charts of the pilot's improvement in holding the aiming mark, providing commentary on them with appropriate text containing specific recommendations. In order to get specialists interested in maintaining accuracy characteristics we concluded that the only aircraft which should be considered outstanding is the one on which results of bombing and firing conform to performance data of the sighting-navigation system. There are other valuable suggestions as well.

Nevertheless, this would not appear to be enough. In my view a need has matured to revise the system for evaluating results of tactical application. It seems to me that in a tactical flying exercise, especially when group flights are being conducted, it is advisable to give an overall grade based on the minimum indicator. In that case problems existing in the collective will begin to show up more sharply, which means there will be more attention paid them. A good grade must not have dark hues.

6904

Energiya Booster Rocket Ground Support Complex Described

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[Article by V. Karashtin, doctor of technical sciences, professor, under rubric "Space Flight Support": "'Energiya' on the Launch Pad"]

[Text] *The Soviet Union began design-flight tests of the Energiya general-purpose booster rocket in the year of the 70th anniversary of the Great October. Its first launch was at 2130 hours Moscow time on 15 May.*

The new Energiya booster rocket is intended for placing both reusable manned spacecraft as well as automatic craft of different sizes into space. With a launch weight on the same order as the American Space Shuttle, it carries a considerably larger payload. This was achieved by a more rational booster configuration and by the throw weight. While the weight itself of the American Space Shuttle is a component part of the overall weight of the load placed into space, the payload in the Soviet design is removed from the booster weight; it is essentially a third stage. That approach permits not only gaining in throw weight, but also making the payload's final-acceleration engine simpler and more reliable.

Like the first Soviet Sputnik booster rocket, the Energiya is made in "packet" form: four side units are the first stage and a central unit is the second stage. The booster is 60 m high, maximum transverse dimension is around 20 m, and second stage diameter is 8 m. Each first stage unit has the world's most powerful liquid-fuel rocket engines, each with a thrust of 800 tons and operating on oxygen-hydrogen fuel. The thrust of each of the four second stage oxygen-hydrogen engines is 200 tons.

Collectives of many research, design, production, and construction-installation organizations and enterprises as well as military specialists took part in the creation and tests of the booster rocket and the unique launch complex.

The article being presented to the readers tells about the unique launch complex and preparation of the Energiya booster rocket for launch at Baykonur.

The structure of ground support complexes for the preparation and launch of rocket boosters was developed throughout the period of development of space technology and it was optimized by the trial-and-error method in all countries which had this equipment. The complexes presently consist of a number of facilities spread out over a large area, which was dictated by requirements of their mutual safety in case of possible non-standard situations both within the facilities themselves as well as outside during a rocket accident at launch.

A similar layout scheme was made the basis of the complex from which the heavy general-purpose Energiya booster rocket was launched. But the dimensions and weight of the booster rocket, power of the engines, and requirement for ensuring high insertion accuracy and operating reliability placed unbelievably higher demands on the design and technological solution of every system and every piece of hardware of the ground complex.

Storage areas for fuel components—liquid hydrogen and oxygen—are spherical tanks with shielded vacuum insulation. Considering their special explosion hazard, the tanks were placed a considerable distance away from the launch facility where the rocket stands. Less dangerous components and compressed gases are located relatively close to the launch facility. Servicing is from a mobile tower which is "rolled" to the booster rocket; its special platforms provide access to essentially any assembly, including the payload assembly. This tower is removed to a safe distance before beginning the process of fueling the booster rocket.

All pneumatic-hydraulic and electrical connections of ground equipment with the booster rocket are made through the rocket base and lateral surface by means of a fueling-drainage mast with movable platforms along which lines for fueling and drainage as well as "ground-rocket" electrical communications cables are run. These platforms are removed in turn in accordance with the technological chart, and the last one (where the oxygen drain line runs) is removed after engines start up and the rocket begins moving. It weighs over 20 tons and requires several seconds for removal, but all the difficulty lies in the fact that in these several seconds this weight has to be slowed and smoothly stopped. This problem was solved after a serious engineering study and a large amount of experimental work.

The launch facility on which the booster rocket stands and from which it starts is a reinforced concrete structure containing mechanisms for holding the booster rocket and facilities for running the pneumohydraulic and electrical connections to it. Beneath it is a deepened single-slope trough for diverting gas from engine units when the booster rocket is launched. A portion of the gas diversion channel is closed with a special sliding floor providing safety for service personnel and access to the booster rocket base during preparatory work. In order to picture the grandeur of the complex, suffice it to say that an average city block with 12-story buildings can be accommodated in the trough.

Especially complicated technical problems had to be solved in creating the fueling systems. Over 4,000 actuators allow simultaneous fueling of all ten booster rocket tanks. It is necessary to have a mean temperature of supercooled liquid hydrogen with an accuracy greater than 1K. Deviations in each tank's fueling level must not exceed 10 mm, and this with the gigantic dimensions of the booster rocket tanks.

The principle of cryogenic cooling to increase metal strength was used to reduce the weight proper of the booster rocket and its systems. As always you gain in some areas and lose in others. For example, filling a number of onboard cylinders with gases is permissible in this case only after the level of the liquid cryogenic component is higher than the cylinders. Consequently the cryogenic component can be discharged only after gas is discharged from these cylinders. There is a multitude of such "little knots" even in a standard technological process and so it became clear from the very beginning that the prelaunch preparation process must be automated to the maximum.

The high degree of automation and use of the most up-to-date mathematical methods for formalizing technological processes of preparation and launch represent one of the primary features of the Energiya booster rocket ground complex.

The launch complex automated control system is built according to the hierarchic principle and has three levels with an overall total of more than 100,000 commands issued and signals received. The first level directly involves the rocket and acts as a "conductor" with respect to systems of the second level and in some cases also the third level. Not one process can begin in lower level systems without a command or authorization of the higher level, and only it can issue commands to the rocket's actuators up to the moment for beginning start-up of engines.

The complexity of creating an automated control complex lay in its development in parallel with the booster rocket and launch complex. As previous experience suggested, the technology of booster rocket and launch complex operation changes in the course of tests. Considering these features, it was deemed irrational to use traditional programming principles.

As a result of tests we found a fundamentally new approach to software and to the structure for building automated systems for prelaunch preparation. This approach consists of representing the process for managing tasks of various classes in the form of a model of a discrete automatic device over time. This permitted not only designing the required gear in advance, but also making a quality leap in efficient control of the ground complex.

The rejection of traditional programming and the transition to a declarative representation of knowledge of the technological process of launch preparation permitted excluding the programmer as a middleman between the controlling computer and the tasker, the process engineer. Data is input directly to the computer in the form of graphic models.

Inasmuch as the rules of functioning are uniform for all models, then using the controlling computers we managed to create a general-purpose automatic device which provides full automated control of the booster rocket's preparation for launch based on readings of the current state of sensors, booster rocket actuators and commands of second level systems.

Realization of this approach sharply increased reliability of control and provided an opportunity for making prompt changes to it. Productivity of stages of the new process compared with traditional ones used for computers rose 10-100 times.

The law of prelaunch preparation control also takes into account many nonstandard situations. It not only registers them, but also suggests how to get out of them. Over 500 nonstandard situations at the very least were transformed into standard built-in situations.

Upper level control operators are located at consoles with three color displays and, if there have been delays in individual operations in second and third level systems,

they issue no more than 3-5 commands for going on to the next process. At all other times they are monitoring progress of the technological process based on data on the displays.

A person who is involved in space technology knows that there are no simple launches. Each one is connected with specific emotions, uneasiness and anxieties. Therefore one can understand the state which gripped all participants in the launch of the Energiya general-purpose booster rocket when the State Commission made the decision for its launch on 15 May 1987. The report on the readiness of the ground complex and booster rocket for launch on 12 May was made to Comrade M. S. Gorbachev, who was at Baykonur at that time. The CPSU Central Committee general secretary had given special attention to the new space system and expressed certain criticism. Now it was necessary to show by action that the developers and testers had taken additional steps and checked the correctness of technical solutions they had adopted.

The prelaunch preparation and the launch went precisely and efficiently. The operators practiced repeatedly in advance, studied operational documentation well and took account of the experience of working with preceding experimental booster rockets.

The technological schedule for prelaunch preparation always provides a certain amount of reserve time to remedy possible faults. Such reserve time also was contained in the Energiya launch schedule. It happened that we were forced to use it.

In the process of cooling a tank with gaseous hydrogen one of the actuators "stuck" in an intermediate state and ceased to react to control commands. It was at this moment that the flexibility built into the automated control system was needed. Without interrupting all other processes for the nine remaining tanks and other parallel operations, we identified the sector of the technological process connected with the "stuck" actuator.

Under a special program compiled by the technical leadership we performed a diagnostic test to determine the true position of this actuator and then it was placed in the necessary position by specific commands. Several additional commands were issued during delivery of liquid hydrogen to the tank and it reacted to them precisely. It functioned just as precisely subsequently as well.

The time reserve built into the schedule was more than that spent to remedy this nonstandard situation, and so launch preparation ended early. The entire ground complex and booster rocket stood in full readiness for several tens of minutes.

The launch was made exactly at the designated time. The command post, where reports on the progress of the automatic launch preparation process had just been sounding, fell silent. When the measuring post which was processing telemetry in real time flashed on the screen "Booster rocket second stage engine switched on at prescribed time. Payload separated," all command post rooms erupted in a thunder of applause.

The first step of a qualitatively new development of space has been taken, but a great amount of difficult work lies ahead.

6904

Having Mental Flight Image Improves Flying Skills

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[Article by Lt Gen Avn N. Kryukov, Honored Military Pilot of the USSR; and Lt Col Med Serv A. Vorona, candidate of medical sciences, under the rubric "Flying and Psychology": "A Feel for Flying"]

[Text] Such expressions as "a bird's sense," "an eye for flying," "sense of the controls," "sense of the machine" and others approximately identical in meaning have long existed in flying practice. Over time some of them have been transformed into the concepts of a "flying sense" and a "sense of the aircraft."

When there were hardly any instruments in aircraft the meaning of a flying sense was absolutized to such an extent that a pilot who did not have it was considered an "imaginary value." As aircraft became saturated with instrumentation, as the theory of instrument flying developed, as instances of the appearance of illusions recurred and with the broad introduction of automated control systems (SAU), the importance of the flying sense for piloting was downgraded and at times entirely disclaimed.

But experience showed that the visual detection and identification of enemy aircraft and maneuverable aerial combat with power maneuvering remained the important things for a fighter pilot despite the "omnipresence" of electronics. It turned out that along with an ability to use various instrument data, he has to possess an ability to directly reflect the aircraft's spatial displacement in the air. Subjectively this is experienced as a sense of the spatial position of his aircraft and its power and the ability to react almost instantaneously to various flight situations.

From the standpoint of modern science a flying sense represents the pilot's ability to make use of noninstrument signals for flying: the position of the aircraft's visible parts relative to natural reference points, angular and linear accelerations, engine noise, and vibrations, which for the experienced pilot are filled with important

flight information. Experiments and scientific observations have confirmed that with modern training methodology such an ability comes to a pilot after 1,000 or more flying hours. But even after this even highly rated pilots spend 95-98 percent of the time monitoring instrument readings even during visual flying.

Thus purposefully forming a flying sense today becomes an urgent and acute problem which can be solved only with a clear understanding of processes occurring in the mind of the pilot flying the aircraft.

Studies have established that a person's conscious actions are governed by a mental image which permits getting oriented in the external environment and expediently organizing one's behavior. That image is not simply an imprint or snapshot of an external situation, but a model of surrounding activity which a person builds on the basis of active cognitive actions in the process of mastering the trade. This model permits him to refrain from forming a new image in any situation and to draw from memory a ready-made, standard image, updating its specific differences and discrepancies by means of incoming signals. The process of cognition through comparison of current data with standards of memory has been given the name "comparison." A characteristic feature of the act of comparison is the speed and seeming ease of putting diverse information together into integral impressions of objects or current situations, but for this it is necessary that the standards formed conform to actual reality to the maximum.

The flight image serves as a concentrated expression of mental images governing a pilot's actions in the air. Its base component consists of visual impressions of aircraft movement and spatial position. A well developed base component permits understanding and correctly using the sum total of data coming to the pilot in flight. The data are divided into instrument (instrument readings) and noninstrument (one's own sensations and perceptions of the position of visible parts of the aircraft relative to natural reference points, forces on controls, load factors, noises, vibrations and so on). In order to identify a flight situation by the comparison method the pilot must have in his memory standard images of instrument readings and noninstrument signals in the form of sensory impressions of the nature of visual perceptions and vestibular, muscular and tactile sensations for various parameters of the aircraft's spatial displacement. It is their totality that is the basis of flying sense.

Here it is necessary to distinguish the concepts of "flying sense" and "sense of the aircraft," often used as synonyms. A flying sense is the pilot's capability for sensory reflection of spatial displacement as a whole, the basis being the entire system of various sensory impressions. A sense of the aircraft is the actuating component part of flying sense. It is connected with impressions of muscular and tactile sensations when flying a specific aircraft and is dictated by the aircraft's stability and controllability. A flying sense gives the flight image the features of a system, since because of it the reflection of the aircraft's position in space acquires an integral character and becomes comprehended. Therefore it is difficult to solve the problem of effectively forming a flight image without the systematic and conscious development of a flying sense.

Meanwhile there are at the very least three interrelated factors which if ignored in flight training at the present time make the formation of a flying sense (which means the formation of an integral flight image) in pilots spontaneous and ineffective.

Modern psychology has proven that visual images are a mental form of the existence of concepts. In pilot activities they are characterized by the creation of three-dimensional visual structures concerning the aircraft's spatial displacement, which in itself is a complex task giving rise to major subjective difficulties. On the one hand, visual impressions differ noticeably in different people in vividness, distinctness and controllability. It is easy to see this if we ask several persons to describe one and the same object very familiar to them. Therefore in reading one and the same texts and with one and the same explanation from the flight instructor, cadets may form different subjective images of the aircraft's spatial positions on a given leg of the flight and different concepts of instrument readings and the nature of noninstrument signals corresponding to them.

Further, demands placed on cadets often are limited only to the presence of knowledge about flight parameters reflected in instrument readings, which is largely facilitated by the methodology of simulator classes held before the beginning of introductory flights, a methodology without real scientific substantiation. As a result conditions are not created for forming integral impressions of the information signs reflecting the aircraft's spatial displacement, which substantially hampers "seeing" and "sensing" the real flight situation.

And here is one other point. Up to the present time various texts on flying techniques (and accordingly the explanations of flight instructors) gave negligibly little attention to the possibility and necessity of using noninstrument signals for control in visual flight. Strange as it may seem, much time in training cadets is given to purely instrument flying. In particular, circuit flying is replaced by flying with two 180 degree turns. Adherents of this method refer to the fact that on the one hand airfield radiotechnical equipment allows making such a landing approach and on the other hand this allegedly creates favorable opportunities for teaching cadets to land. They do not take account of the fact that under combat conditions the likelihood that airfield navigation systems will be out of order substantially increases. And

they forget entirely that this method of approach provides no opportunity to use various noninstrument signals and consequently no opportunity to develop a flying sense.

All this hampers the formation of an integral system of mental expression (a standard flight image), leaving the accumulation of extensive flight experience, i.e., the method of trials and errors, as the only way to acquire it. As a result development of a flying sense stretches out over long years and many pilots cannot describe or explain in detail how they finally learned this because of the unawareness of using noninstrument signals.

The methodology of reference points permits effective development of a flying sense during training and because of this accelerating the process of forming a flight image. Its essence is that all flying figures are divided into elementary standard sectors (reference points). For example, the sector before entry, entry into a 360 degree banked turn, a 360 degree steady banked turn, and exit from the turn; the sector ahead of entry into a half-roll, entry into the half-roll, the inverted position and so on. Several dozen such typical flight "templates" are gathered. Trainees form clear and precise impressions of the aircraft's spatial position, corresponding instrument readings and sensations during ground training with the use of simple technical equipment (slide projector, slides showing instrument readings and a view of the aircraft's visible parts relative to natural reference points in a specific sector of a flying figure, and aircraft models). Under a teacher's supervision, after a slide is shown the cadet places the aircraft model in the necessary spatial position relative to the x, y and z axes and gives a detailed verbal description of sensations and perceptions arising in flight at the given moment. He simultaneously announces what movements of controls are necessary to place the aircraft in the next sector of the figure. After this he is shown the next slide.

After confident assimilation of all reference points in a strict sequence, the slides are shown in random order. The trainee has to quickly interpret instrument readings, place the aircraft model in the appropriate position and report the nature of sensations which will accompany this situation. The time for showing the slides is gradually shortened to one second and less. That is how an ability is developed to precisely translate instrument data into visual impressions of an aircraft's spatial position.

The slides are shown with deviations in the final phase of such training. The trainee not only has to detect them, but also announce how they are reflected in sensation and perception.

In a real flight the impressions formed by using the noninstrument signals most informative at the given moment while monitoring the instruments are filled with specific live content (a subjective assessment of the dynamics of the load factor and forces on controls, the position of visible parts of the aircraft relative to natural reference points and so on). By commands over the SPU [aircraft intercom system], the trainee's attention is specially directed to opportunities for sensory reflection of spatial displacement by rational use of noninstrument signals coming through various sense organs for regulating actions. Instrument data are "connected" to flying only where objectively necessary and where they are irreplaceable: in transitional regimes, to monitor accuracy of flying, or to check operation of the power plant, fuel system and life support systems.

The most powerful methods charge for such training is contained in aerobatics flying when the aircraft's spatial position is constantly changing and the noninstrument signals corresponding to each section of the figure are well perceived and fixed in memory against the background of the visual picture of the displacement of visible parts of the aircraft relative to the natural horizon. Therefore constant pilot training in aerobatics is a necessary condition for developing and maintaining a flying sense.

Practical training performed with instructor pilots under the proposed methodology substantially increased their capability for sensory reflection when flying an aircraft, which attests to the possibility of developing a flying sense even by experienced aviators in the course of specially organized training.

To prove that this was achieved by purposeful formation of a flight image and in particular of its base component, the image of the aircraft's spatial position in aerobatics, experiments were performed in taking an aircraft out of a difficult position with cockpit blacked out. In all cases the reliability of spatial orientation even in instrument flying was higher by several times for pilots of the experimental group with a better developed flying sense.

This can be explained by the fact that in traditional training a flight image is formed without active participation of the consciousness, which by the way also effectively influences sensory impressions about sensations during flying. As a result pilots do not clearly realize what information their sensations carry about parameters of spatial displacement in the air. In visual flying this hinders use of noninstrument signals for regulating flying actions. In instrument flying an insufficiently developed flight image leads to relatively low reliability of spatial orientation and a relatively large amount of time spent "reading the dials."

Purposeful formation of a flight image in pilots of the experimental group led to the ability to "read" one's own sensations during flying just as in reading instruments. Thanks to the methodology of reference points, different displacements in the air were reduced for them to several tens of typical flight situations. The presence in the

pilots' minds of their integral standard images substantially narrows the range of unforeseen surprises in the air. As a result, in visual flight the pilot confidently senses his spatial position and can devote more attention to performing combat missions. Under adverse weather conditions a consciously formed flight image makes it possible to unfold the entire flight situation in the awareness from its individual signs, which improves reliability of spatial orientation.

Thoughtful, planned and systematic formation of a flying sense and its constant improvement is an uncompromising demand of the scientific organization of flight training. It contains a great deal: an improvement in the quality of flying, success in combat, and flight safety.

6904

Factors in Decision to Land Damaged Aircraft

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[Article by Col F. Ganiyev, doctor of technical sciences, professor under rubric "For the Pilot's Arsenal": "If the Aircraft is Damaged"]

[Text] The airfoils of an aircraft may be damaged in the course of operation or combat actions. This will cause a change in aerodynamic characteristics. In such a situation a pilot has to resolve two problems at the very least: Is it possible to continue flying and how can the damaged aircraft be handled?

Studies show that the symmetry of aircraft flow-around is disturbed above all with damages to airfoils. The picture of the distribution of aerodynamic forces changes and consequently the cumulative forces, especially moments, also change. These changes are a function both of the aircraft's configuration and of the area and location of airfoil damage.

Damages to the horizontal tail and the tip of an aircraft's swept or delta wings lead to perceptible changes in pitching moment and position of the aerodynamic center (Fig. 1). Damage to five or more percent of wing area usually causes a loss in the aircraft's longitudinal stability. The changes of forces and moments are not that substantial, although the appearance of perceptible rolling moments is quite possible.

In horizontal flight the gravity force of the aircraft is balanced by its lift ($G=Y_{лев}+Y_{пр}$). Asymmetry creates a difference of forces on the right and left and generates a rolling moment which remains almost unchanged, since lift is constant in horizontal flight, which means the value $\Delta Y=Y_{лев}-Y_{пр}$ also is preserved. The rolling moment can be represented in the following form:

$$M_x=m_x(\rho V^2/2)Sl,$$

where ρ is air density;

V is flight speed;

S and l are wing area and wing span respectively.

The velocity head drops with a decrease in speed and it will be necessary to increase the angle of attack to maintain horizontal flight. In so doing there will be an increase in the rolling moment coefficient m_x. The rolling arising in a damaged aircraft is eliminated by the controls $M_x = M_{x\text{Э}}$. This equality through the coefficients has the form: $m_x = m_x^{\delta_\text{Э}} \delta_\text{Э}$, where $m_x^{\delta_\text{Э}}$ describes the effectiveness of ailerons. Inasmuch as the value of $m_x^{\delta_\text{Э}}$ changes weakly at low flight speeds and moderate angles of attack, then compensating for the growing value of m_x will require greater aileron angles $\delta_\text{Э}$.

Thus the maximum angle of attack α^* at which one is still able to overcome the roll arising because of aircraft damage is determined by the maximum aileron angle (or angle of remaining aileron), i.e., by the available rolling moment.

This angle of attack α^* limits the reduction in velocity head--it dictates the minimum flight speed of a damaged aircraft. It is apparent that angle of attack also will increase with an increase in normal load factor and flight altitude at constant speed. It follows from this that with airfoil damage additional limitations of regimes appear in an aircraft, above all for minimum flight speed and the the normal load factor value.

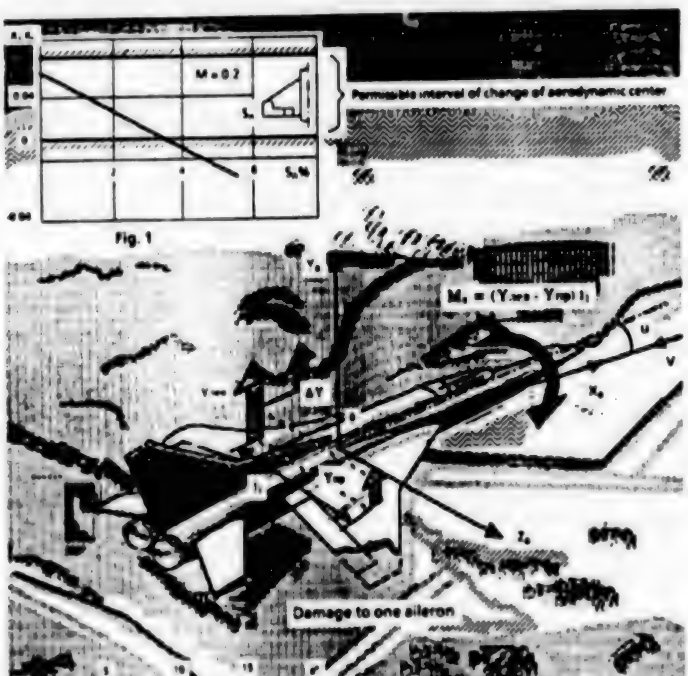
Greatest difficulties in flying a damaged aircraft await the pilot in the landing. The danger is that a damaged aircraft can perform horizontal flight and even a maneuver with limitations in the load factor, but in the landing it is suddenly discovered that the rolling moment which has appeared is so great (because of the increase in angle of attack) that one cannot compensate for it through the controls. The situation also is complicated by the fact that the pilot lacks time to analyze the phenomenon, make a decision and correct possible errors. An abrupt decrease in responsiveness suddenly appears in an aircraft which in previous flight regimes had acceptable stability and controllability characteristics, albeit limited. In addition, in this phase the possibility of correcting a dangerous situation which has appeared is considerably reduced.

Therefore if a rolling moment suddenly appears in flight it is necessary to reduce speed without changing altitude. An increase in the rolling moment here is a sign of the presence of asymmetric airfoil damage. Then one should evaluate whether or not the aircraft can be landed. To do this gradually reduce flight speed at a safe (but lowest possible) altitude. The lowest speed at which rolling moments which arise still can be compensated by using the controls is the primary argument for a decision about the possibility of landing a damaged aircraft. Then if necessary one can try to lower the flaps and clarify the configuration in which the landing will be made. If one of the flaps has been torn off or damaged the rolling moment may change very perceptibly.

Let us examine corresponding graphs to familiarize ourselves with changes in an aircraft's aerodynamic characteristics arising in the presence of airfoil damage. Fig. 2 shows the possibility of compensating for a rolling moment with one right aileron as the angle of attack increases with different relative areas of damage $\bar{S}_{\Pi}=S_{\Pi}/S$ to the left wingtip. For an aircraft with ten-percent damage in wingtip area $\bar{S}_{\Pi}=0.1$ at H=0 and M=0.2 horizontal flight is possible only at angles of attack $\alpha \leq 7°$. An increase in the load factor of a damaged aircraft at the very same speed and flight altitude to compensate for the rolling moment requires a greater aileron angle. An increase in flight altitude at the very same true speed also leads to this.

Consequently, to compensate for the rolling moment arising in a damaged aircraft the aileron travel changes according to speed, altitude and normal load factor.

Fig. 3 depicts aileron angles required for countering rolling moments in creating a unit normal load factor of a damaged aircraft $\delta_э^{n_y}$ as a function of Mach number and flight altitude.



We can recommend the following logic scheme for analysis and evaluation of the possibility of continuing a flight with unusual aircraft behavior. If a roll suddenly appears which does not conform to the position of the ailerons

(phenomenon), then an increase in rolling moment with an increase in angle of attack (dominant sign) provides grounds for concluding damage to the aircraft airfoil (cause). To select the variant of further actions and evaluate the possibility of making a landing, it is necessary to determine in advance the precise value of minimum flight speed at which acceptable lateral stability and controllability characteristics are still maintained. A final decision to land can be developed by comparing this minimum speed with the value of maximum landing speed, limited by other factors (runway length, energy capacity of the aircraft braking system, and so on).

A damaged aircraft is not yet a lost combat machine, but the struggle for its survival demands serious professional competence and high moral and mental staunchness of the pilot.

6904

Flight Safety Service Inspector's Work

91440064g Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 10, Oct 87 (signed to press 2 Sep 87) pp 30-31

[Article by Col V. Grishchenkov under rubric "The Leaders": "The Inspector's Weighty Word"]

[Text] Flights were coming to an end when something unforeseen occurred. In making a landing approach Maj V. Lugin shifted the landing gear cock for lowering. The main legs locked, but the front leg did not lower. Attempts to lower it by the emergency method were unsuccessful.

This occurred during a phase of mastering a heavy missile-armed aircraft in a line unit. That had never before happened on an aircraft of that type. What should be done? In such situations OKB [Experimental Design Bureau] specialists recommend landing the aircraft with the front leg not lowered, but in this way it is impossible to avoid damaging the aircraft. Moreover such a landing requires a pilot to have special proficiency, but did Lugin have enough ability? And if he didn't cope with handling the aircraft? Then a serious flying incident could not be avoided.

Col A. Karpov, senior inspector-pilot of the Air Forces flight safety service who was at the control tower, came to the crew's help. Quickly assessing the situation and making necessary calculations, he advised switching off the g-limiter and trying to lower the leg by creating the maximum permissible g's for an aircraft of this type.

The flight operations officer gave the pilot the appropriate command and the aircraft departed for a second circuit. The front landing gear leg fell into place when the additional load factor was created and the flight ended safely. Later it was learned that the precondition occurred through the fault of IAS [aviation engineering service] specialists.

Col Karpov assumed great responsibility and proved to be up to the mark. Of course in the given instance the word of the Air Forces inspector had special weight, but even in the course of daily combat training his instructions on organizing flight duty, working out planning tables and keeping flight documentation are received for strict fulfillment in units large and small.

Inspectors of the Air Forces central staff have restless, interesting and very responsible jobs. By constantly studying the state of affairs locally, promptly noting positive experience and deficiencies, and demandingly evaluating what has been achieved, they mobilize aviators to further build up quality indicators in mastering flying techniques and in the tactical employment of aircraft; they strive for precise fulfillment of the requirements of documents governing flight operations; and they take vigorous steps to stop violations and immediately remedy the deficiencies uncovered. In order to be a kind of impulse of initiative and of direction toward a search for new and more effective ways of accomplishing the missions facing those being inspected, every inspector must set an example of principle, an innovative approach to the job, professional competence and objectivity.

Col Karpov, Honored Military Pilot of the USSR, performs his duties with a maximum output of effort and with supreme responsibility. He was one of the first in the Air Forces to master a third-generation supersonic missile-armed aircraft. His opinion often is deciding in matters of the organization and methodology of flight training in Long-Range Aviation aircraft, especially for the most advanced kinds of training. He is heeded at all levels.

The mastery and combat employment of new aviation equipment always involves many difficulties. It was also a great credit to Aleksandr Nikolayevich for the fact that there were no flying incidents over a ten-year period in the aircraft for whom Karpov was the leading pilot in the Air Forces. He participated in practically all major exercises of recent times and has flown some 4,000 hours.

What is the important factor in this officer's work? Above all it is the study and analysis of data coming from units and the development of specific suggestions aimed at successful accomplishment of combat training missions and prevention of flying incidents. While he is among the troops Col Karpov delves into the situation in detail; thoroughly studies mistakes and preconditions for flying incidents, especially the correctness of their classification, system of analysis and effectiveness of steps taken; and pays attention to the training and placement in formation of young flight personnel, the status of flight-methods training of instructors, and conformity of the aviators' training level to the complexity of missions being accomplished. The experienced pilot holds classes in which he thoroughly critiques dangerous preconditions for flying incidents and offers recommendations for preventing them.

I will cite the following example. Operation of a heavy missile-armed aircraft in the second (unfavorable) flight regime characterized by low speeds, large angles of attack and a decrease in aircraft stability presents certain difficulties for pilots. In order to understand the essence of what is occurring and give recommendations to flight personnel Col Karpov obtained authorization from the General Designer for a test flight with an Experimental Design Bureau test pilot. After studying the aircraft's behavior at minimum speeds the inspector held classes with the pilots in which he explained the physical essence of what was occurring, gave recommendations for precluding instances where the aircraft entered the second regime and, most important, taught them in training flights the proper actions with an unintentional reduction in speed below that permitted by the instructions.

This played a positive role: there were no such preconditions bordering on flying incidents aboard aircraft of the given type in the Air Forces.

The analysis, conclusions and instructions of representative of the higher body helps aviators perceive mistakes more clearly, become reoriented, and change their work style.

While he was in one of the units Col Karpov learned that young aircraft commanders had flown rarely in the past training year. It is common knowledge that low flying hours and large interruptions hamper the formation of flying skill in aviators who are insufficiently strong in the professional sense and give rise to a number of typical mistakes. People in the unit attempted to justify all this by referring to a campaign for accidentfree flight operations. The recently appointed regimental commander also gave other reasons: unfavorable weather conditions and the people's heavy workload from various additional assignments.

Life and flying experience permitted Col Karpov to determine the true causes of omissions in the organization of flight training. Based on the fact that it is impossible to create even an appearance of high results by reducing exactingness and simplifying the norms, Officer Karpov pointed out unused reserves to the commander.

The regimental commander and other officer leaders drew the proper conclusion that today it is impossible to organize combat training in the old way; one must look for ways of intensifying it, reject stereotypes and fight against all possible indulgences and lack of grading objectivity. At the present moment Aleksandr Nikolayevich is keeping the state of affairs in the regiment under close watch and the situation here is changing for the better.

If the inspector sees that resolution of specific problems of ensuring flight safety goes beyond the bounds of a commander's competence he makes the problems known to higher chiefs and appropriate steps are taken. It is another matter when one has occasion to encounter a conscious infraction of flight safety measures as was the case in the regiment headed at one time by Lt Col V. Knyazev. People undertook to violate requirements of documents governing accidentfree flight operations in pursuit of the plan. The inspector reported the state of affairs to the Air Forces command authority, the regiment was prohibited from flying and Lt Col Knyazev was relieved of his position.

In working with pilots and trying to help them correct the situation Aleksandr Nikolayevich explains mistakes and infractions calmly and in detail. He considers industriousness and honesty to be among the chief qualities. Being a quiet, kind person by nature, he becomes strict and irreconcilable on encountering malicious violators of flying laws who declaim for restructuring in words but who in fact do not give up old habits. For example, on learning that one of the leaders of an aviation subunit was inclined to use alcohol, Karpov not only removed him from flying, but also insisted that he be released from the Air Forces to the reserve.

And so by thoroughly analyzing the state of affairs in units and strictly monitoring precise fulfillment of the rules of flight operations, Col A. Karpov, senior inspector-pilot of the Air Forces flight safety service, stands on guard over flying laws and makes a substantial contribution toward an improvement in combat readiness of Air Forces units and subunits and the assurance of flight safety.

6904

Flight Safety Tips for Technical Maintenance Personnel

91440064h Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 10, Oct 87 (signed to press 2 Sep 87) pp 31-33

[Article by Gds Sr Lt A. Mikhaylov, senior technician of aircraft periodic technical servicing group, under rubric "Flight Safety: Experience, Analysis, Problems": "Check Seven Times (Discussion of the Article 'The Sky Does Not Forgive Errors')"]

[Text] I was prompted to take part in the discussion of Lt Col V. Antyufeyev's article by the atmosphere of businesslike activeness and principled exactingness established in our technical maintenance unit. This is understandable, for that is the demand of the time! That is just how the question was posed at the June 1987 CPSU Central Committee Plenum: increase each person's responsibility for the state of affairs in his own work sector.

Specific changes in the work of our subunit's engineering-technical personnel are quite obvious. The collective is working rhythmically and the aviation specialists' technical culture, efficiency and discipline noticeably improved. Most important, however, probably is the fact that the attitude toward the job changed. I recall how much we spoke previously about quality performance of periodic technical servicing! We persuaded and appealed, but we sometimes forgot about the specialists themselves and their working conditions. Now it is a different matter. The focus of attention of commanders, political officers, and party and Komsomol organizations is on the people and their interests, concerns and needs. This is when the human factor genuinely became a powerful motivator of the collective's labor achievements.

Our priority concern is operating reliability of aircraft. Flight safety and the air unit's combat readiness depend on that to a considerable extent. Very high demands are

placed on ensuring operational reliability. These demands are generally known. Nonfulfillment of just one of them leads to a reduction in this reliability, which is fraught with preconditions for flying incidents.

Many aircraft come to our technical maintenance unit for periodic technical servicing, and in order to place them in operation promptly we had to switch over to two-shift working conditions. The fact is, however, that anything can happen in life. Let us say one of the aviation specialists got sick, left on TDY or went on a daily detail. In order not to get shoved out of the rigid technological schedule, the others have to perform an enormously larger amount of work and have to work both for themselves and for the temporarily absent comrade. Here is where the knowledge of related operations and innovation came in handy for our personnel.

Precisely adjusted operation-by-operation monitoring also plays an important role in improving the quality of periodic technical servicing and of flight safety.

What else is noteworthy in our periodic technical servicing group? You sometimes look at your comrades and admire their work. Guards warrant officers [praporshchik] A. Voronin, A. Aruyev and I. Artemov and Gds Pvt V. Kulik can successfully perform periodic technical servicing from many route charts, inspect various assemblies, units and systems, and perform diverse installation and dismantling operations. In short, there can be no doubt of the high professional expertise and firm skills of our foremost personnel. They are able to organize their work so that it is useless to look for flaws. But that is the way it is in aviation: it is better to check everything seven times and be sure of precise fulfillment of a particular operation so as later to be sure that the equipment will not let the pilot down in the air.

I could name many more of my colleagues who set examples of compliance with the norms of technical culture and diligence, but let us think in a new way: see each person behind the majority and draw up laggards to the level of the leaders. This is required by the interests of combat readiness and flight safety.

As with any other combat equipment, an aircraft is a collective weapon. The blunder or carelessness of one specialist threatens serious consequences. It is very important not to lose sight of anyone here, just as we did not.

Young mechanics who had yet to completely understand the need for a self-check and mutual check in working on the equipment were given a graphic lesson: experienced specialists showed in practice where laxity, inattentiveness and scorn of operation-by-operation control in working on the equipment could lead. Before trying out an engine on an aircraft they deliberately did not cotter one of the nuts located in a zone of increased vibration. They started the engine and the nut unscrewed by itself several tens of seconds later. It was seen that this lesson was more convincing and effective for the young specialists than theoretical discourse and calls to work conscientiously and not allow defects.

The "sore spots" and operations subject to mandatory control are determined in the process of operating aviation equipment. The process chart precisely reflects who monitors what and when. It remains for aviation engineering service specialists only to quickly fulfill the prescribed points.

It has become the rule for us to check not only the end result of work, but also fulfillment of intermediate operations. This is done because when an assembly has been put together it is already impossible to find out whether or not components have been installed correctly. Let us say a mechanic is assembling the landing gear. If he places the bearing oil seals in the seat the wrong way around and no one notices this the bearing can fail when the aircraft lands. The fact is that when the wheel is assembled it is of course already impossible to determine correctness of oil seal installation.

Two-shift work requires full exertion of effort from each of us. It is common knowledge that at night more thorough operation-by-operation control is necessary: fatigue sets in faster at night, vigilance dulls and the absence of daylight also has an effect. Under such conditions the likelihood of errors appearing increases, which in turn requires a more careful check of the quality of work performed on aircraft.

It stands to reason that there are different kinds of control, but the basis of the flight safety campaign is not only strict compliance with the processing method, but also high awareness, conscientiousness, composure and discipline of aviation specialists and an intolerance for any kind of deficiencies. These are the qualities which we try to instil in subordinates in the course of their training.

I would like to mention one thing more. It will be about the technical culture of aviation specialists. In our time it is seemingly awkward to speak about cleanliness at the work station. This should go without saying, but it has to be mentioned because there are still specialists who erroneously assume that a parallel cannot be drawn between technical culture and esthetics of military labor on the one hand and matters of ensuring flight safety on the other. If we think well about it, however, it will become clear to everyone that there is a very close relationship between these concepts. It is common knowledge that where there is dirt, look for a defect which can lead to serious consequences. An aviation mechanic who is able to rationally organize his work station and lay out tools and inspection-test gear so that they are always at hand spends enormously less time on unnecessary searches for the required device or instrument.

It is a real pleasure, for example, to observe how Gds WO A. Voronin and Soviet Army Employee I. Zhilin work on the equipment. They will prepare the necessary tools and expendable supplies before beginning performance of operations on the aircraft. They essentially do not make a single superfluous movement. As a rule, the quality of their work is high.

But a specialist who works in a slipshod manner, as they say, is immediately apparent in the collective. He is given away by his personal lack of organization and the inability or lack of desire to strictly regulate his work on the aircraft. I would like to touch on the following question in connection with this. For some reason the concept of high technical culture is associated by some only with detailed technical knowledge. It is self-evident that this is the first condition in working on modern aviation equipment and the motto "An engineer's knowledge for every technician" is not a fashion, but a demand of the times. It is becoming more and more difficult to get by without such a voluminous store of knowledge. The problem is posed as follows: an aircraft technician not only has to know the design of the aircraft and engine to perfection, but also have sufficient information about its equipment and armament and know the list of jobs on them, i.e., the technician is obligated to be a specialist of a broad profile.

I have had more than one occasion to observe how knowledgeable and conscientious specialists suddenly became culprits of preconditions for flying incidents. In fact if there is no strict sequence or specific system in your actions and if you do not have the ability for self-control, no one ever can guarantee you against mistakes leading to flying incidents and preconditions therefor even if you were a Solomon.

Unfortunately slovenliness and lack of organization in working on equipment do not yet always receive a proper evaluation. It also sometimes happens that a first-rate specialist who is a person of high technical culture with detailed knowledge will not make a critical comment to a comrade who by his attitude toward the job just out-and-out insults that specialist's professional pride. Such tolerance, it seems to me, generates irresponsible specialists through whose fault preconditions for flying incidents sometimes arise.

Our technical maintenance unit bears the title of outstanding. On joining in socialist competition under the motto "We will fulfill resolutions of the 27th CPSU Congress and celebrate the 70th anniversary of the Great October with selfless military labor!" we do not intend to surrender the positions we won. One of the main points of our collective socialist pledges is to ensure accidentfree flight operations.

6904

Warsaw Pact Military Doctrine, Force Reductions

91440064j Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 10, Oct 87 (signed to press 2 Sep 87) pp 39-41

[Article by Col B. Lytov, candidate of historical sciences, under rubric "70th Anniversary of USSR Armed Forces": "Doctrine of Peace and Security"]

[Text] It was January 1918, the time when the Red Army was originating and the working masses were forming their attitude toward it. From the first days of the new Army's creation simple people saw it as their defender. As confirmation of this, speaking at the 3d All-Russian Congress of Soviets, V. I. Lenin quoted the words of an old Finnish woman which he overheard in a car on the Finnish Railroad: Now one doesn't have to fear a person with a gun, since when she met him in the forest he not only didn't take the brushwood from her, but even added more and helped her take it home.

"When I heard this," remarked Vladimir Ilich, "I said to myself: let hundreds of newspapers, no matter what they are called there—socialist, almost-socialist and so on—and let hundreds of extremely loud voices shout at us: 'dictators,' 'tyrants' and similar words. We know that a different voice now is being raised among the popular masses. They are saying to themselves that one doesn't have to fear a person with a gun because he is defending the workers and will be merciless in crushing the domination of exploiters."

The organization and technical outfitting of the Soviet Armed Forces have changed radically over the past years. The children and grandchildren of those who stormed the Winter Palace and defended the socialist homeland in the menacing years of the Civil and Great Patriotic wars now are in their formation. But the essence of the Army born of the Great October Socialist Revolution remains the same: express the people's fundamental interests and stand guard over the peace and labor of Soviet citizens.

Under present-day conditions the USSR Armed Forces are a reliable bulwark for those whom history has assigned a mission of exceptional importance: to defend the cause of peace and safeguard mankind against nuclear catastrophe.

Countries of socialism act as the principal force in the campaign for peace and international security. The economic foundation for waging unjust, predatory wars—private ownership of the means of production—has been destroyed forever in them and there are no classes or social layers interested in wars. Socialism and peace are indivisible.

The military doctrine of socialist states adopted at a session of the Political Consultative Committee of Warsaw Pact Member States in Berlin in May of this year is vivid confirmation of the genuinely peaceable nature of

their politics. The open proclamation of objectives and tasks in the military area by countries of the socialist community and parties to the Treaty was taken by the world public as the aspiration of the USSR and its allies for international trust, without which it is impossible to form an all-encompassing system of equal security for all.

The basis of the military doctrine of the USSR and other socialist states is a new political thinking which permits realistically seeing the contradictions of the present-day world, the interrelationship and interdependence of security of all states, and their common responsibility for mankind's future. With the objective of preserving peace, at its 27th congress our party advanced the idea of creating an all-encompassing system of international security and spelled out the strictly defensive nature of Soviet military doctrine. All activities of other socialist states in the military area also carry bear a strictly defensive character.

It was reaffirmed at the session of the Political Consultative Committee of Warsaw Pact Member States that their military doctrine bears a defensive character and proceeds from the need for maintaining a balance of military forces at the lowest possible level and the advisability of reducing military potentials to limits of sufficiency necessary for defense.

That approach to defining objectives and tasks in the military area is profoundly realistic and genuinely innovative.

First of all, the military doctrine of the USSR and other socialist states reflects concern not only for their own security, but for universal security as well. Thus the age-long egotism inherent to countries belonging to antagonistic formations has been overcome. The nuclear-space era dictates a different approach to ensuring security. Comrade M. S. Gorbachev noted that under present-day conditions the supreme wisdom does not lie in being concerned exclusively about oneself, especially to the detriment of another party. It is necessary for everyone to feel that they have equal security, since the fears and alarms of the nuclear age give rise to unpredictability in politics and in specific actions. Based on this the document adopted at the Political Consultative Committee session states that socialist states do not lay claim to greater security than other countries, but also will not accept lesser security.

Secondly, Warsaw Pact countries also took a new approach to defining the essence of their defensive measures. Their efforts are aimed not simply at creating an effective defense, about which much also has been said in the past, but chiefly at the prevention of world war. That approach is dictated by the catastrophic consequences of any worldwide armed conflict both with or without the use of nuclear weapons. The document states that the world has become too fragile for war and power politics in the nuclear-space era.

Thirdly, the military doctrine of socialist states also clearly defines the main ways to ensure reliable security: reducing the level of military opposition, stopping the arms race, and directing funds removed from military budgets as a result of their reduction to the needs of economic and social development of their own states and to assist liberated countries. All this reflects the exceptional humaneness of the military doctrine of the USSR and all countries of socialism.

As noted in the document adopted at the Political Consultative Committee session, the essence of this military doctrine is that countries of the socialist community never will be first to begin military actions nor will they be first to employ nuclear weapons. They have no territorial claims of any sort on other states, an image representation of the enemy in the person of other countries is absolutely alien to them, and they are building all their international relations on the basis of principles of respect for independence, national sovereignty, nonuse of force or threat of force, inviolability of borders and territorial integrity, conflict resolution by peaceful means, nonintervention in internal affairs, legal equality, and other principles and objectives provided by the rules of international law.

The military doctrine adopted by the allied socialist states is not limited to proclaiming their political objectives and tasks or declaring their love of peace. Many assurances of a desire for peace also are found in declarations by political circles of capitalist states. The effectiveness of the military doctrine of the USSR and other countries of the socialist community lies in the fact that it contains specific proposals aimed at strengthening peace and international security. In particular it is proposed to totally eliminate nuclear weapons, not allow the arms race to spread to outer space, ban and eliminate chemical weapons and other kinds of weapons of mass destruction, reduce armed forces and armaments to a level precluding a surprise attack and the capability of conducting offensive operations, and provide for verification of disarmament measures using all accessible means including an exchange of military information and on-site inspections.

The military doctrine gives great attention to implementing confidence-building measures among countries belonging to different military-political alliances. Among these measures, which could be implemented in the very immediate future on the basis of a mutual agreement, are the establishment of zones free of nuclear and chemical weapons and zones of reduced concentration of arms and increased trust; rejection of the use of military force; and pledges to maintain peaceful relations.

With a growth in confidence in each other it would also be possible to agree on taking such steps as eliminating military bases on the territories of other states, drawing troops back behind national borders, mutually removing the most dangerous kinds of arms from a zone of

immediate contact of two military alliances, and reducing the concentration of armed forces and arms in this zone to an agreed-upon minimum level.

The Warsaw Pact countries propose to go even further than these important but still partial steps for ensuring international security. They regard the continuing split of Europe into opposing military blocs as abnormal and favor the simultaneous dissolution of the North Atlantic Alliance and Warsaw Pact, and elimination of their military organizations as a first step. Implementation of this proposal would lead to a radical normalization of the international situation and a strengthening of peace and would permit realizing in fact the idea of creating an all-encompassing international security system advanced by the 27th CPSU Congress.

That is the political essence of the military doctrine of allied socialist states. The military-technical aspect of the doctrine, which specifies the purpose and direction of organizational development and training of the armed forces, also is in dialectical unity with it.

According to its purpose the army always has been considered a tool for implementing state policy and an instrument for making war, but the USSR and allied socialist countries believe that it is inadmissible to use the military path for resolving existing contradictions. They intend to use their armed forces to preserve the peace and protect the socialist achievements of their peoples.

The presently existing international situation and the positive trend it contains also determine the direction of organizational development of the armed forces of socialist states. Under conditions where the world situation remains very complex and strained, they are being kept at that level which would allow them to repel any attack from without. In case of success in disarmament talks with NATO countries the armed forces of the two opposing military-political groupings can undergo serious reorganization. Strategic nuclear forces and offensive kinds of arms can be reduced and removed from their order of battle and the grouping and stationing of troops can be radically changed. For example the allied socialist states favor a 50-percent reduction in strategic offensive arms of the USSR and United States over a five-year period and talks on their subsequent reductions. Countries of socialism propose to destroy nuclear weapons entirely by a phased reduction in nuclear arms.

It is proposed to reduce conventional arms by 25 percent in the early 1990's. By following the path of limiting and reducing nuclear and conventional arms, Warsaw Pact and NATO countries could create armed forces within the framework of the existing military-political alliances which by their size, order of battle and grouping would be capable of conducting only defensive combat actions. Thus the threat of unleashing wars or major armed conflicts would be precluded.

The defensive nature of the military doctrine adopted by Warsaw Pact member states also specifies a new approach to troop combat training. The chief factor in training army and navy forces today consists of their retaliatory defensive actions to repel enemy aggression. They train for combat actions to defeat an aggressor vigorously and resolutely. The principle of teaching troops what will be necessary in a combat situation remains the basis of their combat training.

Military doctrine also places high demands on combat readiness of armed forces. The growth in imperialism's aggressiveness, the continuing arms race and the absence of actual agreements in the military area between the USSR and the United States and other NATO countries make the world situation exceptionally tense. As noted by USSR Minister of Defense Army Gen D. T. Yazov, under these conditions our Armed Forces are kept in a state of combat readiness sufficient to keep from being caught unawares, and if nevertheless an attack is made on us, they will give the aggressor a crushing rebuff.

That is the essence of the approach by the USSR and other socialist states to the very important issues of organizational development and strengthening of the armed forces.

Promulgation of the military doctrine by Warsaw Pact member states is of great significance. Glasnost makes it possible for peaceloving forces of capitalist countries to compare military doctrines of the USSR and United States and of Warsaw Pact and NATO countries, to campaign against the aggressive essence of the politics of imperialism, and to consistently defend the cause of peace. Adoption of the military doctrine document at the Political Consultative Committee session also is important for further cohesiveness of socialist countries on tested principles of Marxism-Leninsm.

In fervently approving party policy and the document on the military doctrine of Warsaw Pact member states adopted in Berlin, Armed Forces personnel including military aviators realize their high responsibility for the Motherland's security and the Soviet people's peaceful, creative labor. In heading toward the glorious jubilee, the 70th anniversary of the USSR Armed Forces, they are constantly improving their combat proficiency, strengthening efficiency, order and discipline, persistently struggling to fulfill their socialist pledges, and are always ready to defend peace and socialism. Comrade M. S. Gorbachev said at the June 1987 CPSU Central Committee Plenum: "I firmly declare on behalf of the Politburo and Defense Council that neither the party nor the people should have any doubts as to the ability of the USSR Armed Forces to defend the country."

6904

Air Defense Penetration Aids
91440064k Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 10, Oct 87 (signed to press 2 Sep 87) pp 46-47

[Part 1 of article based on foreign press materials by Col (Res) V. Dubrov under rubric "Weapons of Aggression and Brigandage": "Means and Methods of Penetrating Air Defense"]

[Text] The term "air defense penetration" appeared for the first time in U.S. Air Force regulations after experience was gained in combat actions in the sky of Vietnam. The American journal ORDNANCE wrote that the combination of air defense weapons defending Hanoi and Haiphong differed from all those previously known. New means of combating aircraft in the air were combined with old ones and had high density in a limited area. Under these conditions it was difficult to employ the traditional tactics of air strike forces designed for bypassing danger zones and the procedures for evading antiaircraft fire over the target. It was necessary to penetrate directly head-on to the strike objective inasmuch as there was no other way. This active method of overcoming air defense was called the "penetration."

The very first attempts at penetration demonstrated its negative and positive aspects. Foreign military specialists included among deficiencies that the aircraft were constantly in the impact zone of surface-to-air missile systems (or of AAA) and as a consequence there were heavy losses. An advantage was considered to be flying to the target over the shortest distance, i.e., the approach to the target in minimum time. This gave the hope of achieving surprise and reducing the opposition of interceptors, which had a relatively slow reaction time (compared to ground air defense weapons) when taking off from a base airfield. Thus this method of overcoming air defense was employed under conditions of the most active opposition of enemy air defense weapons.

Inasmuch as the procedures of "evasion" and "avoidance" in a zone of solid air defense fire produced no effect, maneuvering too could no longer be the basic means of protection for strike groups. More effective methods of combating air defense were needed. The first conclusion was obvious: with a limited arsenal of procedures a tactic of "fighting fire with fire" was needed, i.e., air-to-surface weapons should be used that were specially designed to destroy air defense targets. Antiradar missiles such as the Shrike with passive homing on the beam of a locked-on radar appeared on some American fighter-bombers taking part in the air aggression in Vietnam.

The first experience in using the Shrike antiradar missile was not very comforting, but experiments continued under combat conditions. It was necessary to solve many problems in short time periods. In order to arrive at the attack line and launch the antiradar missile it was necessary first of all to obtain the coordinates (even if only approximate) of the strike objective—the ground radar; secondly, to maintain parameters of the "standard" maneuver in altitude and range up to the target; and thirdly, to have a guarantee of the invulnerability of an aircraft forced to encroach on an area of aimed ground fire.

Initially the American antiradar missile-carrying aircraft worked together with support groups which included ELINT aircraft and jammers as well as with strike groups (equipped with conventional munitions), which used the launches and bursts of the Shrike antiradar missiles as a means of target designation.

Foreign military specialists noted that updating of the penetration aids led to an answering reaction—a swift improvement in the air defense system. Therefore the number of aircraft penetrating to the target did not increase and combat losses of U.S. aviation in performing so-called "strike operations" did not drop. The numerous support groups suffered considerable losses. This made it necessary to combine the functions of ELINT, jamming and fire engagement of air defense weapons in one special aircraft. The program for creating such an aircraft in the U.S. Air Force was called Wild Weasel.

The first Wild Weasel squadron included two-seat F-105F aircraft converted from F-105 fighter-bombers. In 1970 they were replaced by the F-4 Phantom, which is of sad repute from the local wars in Southeast Asia and the Near East and which has been in these squadrons up to the present time (they were designated F-4G after modernization). To identify and engage air defense weapons crews of the penetration aircraft acting in the interests of strike groups used ELINT gear, a warning set, jammers, chaff dispensers, and antiradar missiles (the Shrike and later the Standard ARM).

One of the features of penetration tactics consists of acting according to the principle of "each against his own target" (primarily single attacks by antiradar missile-carrying aircraft) within rigid time frames in a designated area. Considerations of one's own safety and assurance of swift entry of the strike group into the penetration corridor created rather difficult conditions for aircraft crews, especially in the zone of unsuppressed air defense. The workload of pilot and operator involving the ELINT, ECM, weapons and sighting systems came into contradiction with the mandatory immediate reaction to frequent situation changes, and so the problem of reducing vulnerabilitiy arose acutely for Wild Weasel subunits.

The journal AIR INTERNATIONAL wrote that the U.S. Air Force was modernizing the forces intended for neutralizing air defense weapons with consideration of the experience of the wars in Vietnam and the Near East. The basis of the system is the very same F-4G refitted from the F-4E (a total of 116 aircraft). Special equipment is installed in containers beneath the forward fuselage in place of the Vulcan cannon and in the upper part of the

fin, and the aircraft has 52 additional antennas. In flight the navigator-operator receives data on a target location at the range of radar line of sight. A "library" of threats, which can change (on the ground) after new reconnaissance data are received, is entered in the on-board digital computer.

Plan position indicators, panoramic analysis indicator (lower hemisphere) and homing system indicator are installed in the aircraft's rear cockpit. Data on range and azimuth to a threat target, the antiaircraft batteries and missile systems (after an emission of the radars included in them is analyzed), are presented on the plan position indicator (there is also one in the front cockpit). The highest priority threat is denoted by a triangular symbol. The pilot's optical sight has a red reticle showing the direction to a threat and a green line with shifting crosshair showing the aircraft's path. The pilot can perform instrument bombing (when performing a mission as a fighter-bomber) by lining up both crosshairs (by maneuvering the aircraft). The crew conducts defensive aerial combat using medium-range Sparrow AIM-7 guided missiles and short-range Sidewinder AIM-9L missiles. An active jammer as well as a built-in passive jamming device are used to defend against ground threats.

The APR-38 warning receiver is used to neutralize air defense weapons in the designated area. It performs direction-finding on a source of emission in a zone which the aircraft is entering. The direction to it lights up on the indicator and the digital computer connected with the indicator identifies the type of emitter based on data stored in memory and outputs data to an illuminated display. After the emitter to be neutralized has been selected (automatically or manually) the ALQ-119 jammer, which uses traveling wave tubes covering three bands, begins operating. There is the capability of putting out masking noise jamming and repeater deception jamming, and there are antiradar and thermal decoys fired automatically (after receipt of a signal warning of a missile launch) or manually to disrupt the attack of enemy interceptors or deflect surface-to-air missiles from the pursuit trajectory.

After reading the heading from the warning receiver indicator the pilot flies in the indicated direction. The operator superimposes an electronic marker on the selected radar; then, pressing a button to transmit data to the missile, he inputs data on direction to the target and its emission frequency. After radar lock-on and launch the missile homing head antenna (a round parabolic scanning reflector) determines the target azimuth and elevation. A series of pulses being received is modulated in amplitude and if the target is not in an equisignal direction it produces an error signal proportional to the amount of deviation and forms control commands for automatic guidance of the antiradar missile to the target. An influence fuze detonates the fragmentation warhead above the target (if guidance has not been disrupted because of radar switch-off).

The foreign press reports that the Shrike and Standard ARM antiradar missiles created in the 1960's are to be replaced by the HARM antiradar missile. Guided weapons for air defense neutralization which were tested in local wars have substantial deficiencies, among which specialists include low speed (because of this the flight time to the target after launch is lengthy), limited destructive capabilities, poor homing head selective capability, and unsatisfactory reliability (frequent system failures). But the chief deficiency which could not be overcome during combat actions is considered to be the short range of permissible launch (14-16 km) and in connection with this the need to move to medium altitude (2,500-3,500 m), which does not provide for required survivability of the platform aircraft. In addition, if the target radar ceased operation the homing head became disoriented after the missile's launch.

A more powerful motor (smokeless solid fuel) giving the missile greater speed and flight range was installed in the HARM antiradar missile with the retention of weight and geometric characteristics (weight 354 kg(f), length 4.2 m). The missile has a passive homing head with a broad working frequency band for engaging various radars.

The ALQ-131 set—a self-contained device uniting a jammer, ELINT receiver, digital minicomputer and electric power source—is coming to replace the ALQ-119 jammer aboard Wild Weasel aircraft. The journal AVIATION WEEK notes that the five frequency bands of the jammers can cover the frequency range of all existing air defense radars. There are provisions for a rebroadcast mode to disrupt the operation of an enemy radar tracking the aircraft in azimuth, a spot noise jamming mode to hamper determination of the aircraft's range and speed, and a repeater-pulse jamming mode. A computer joined with the warning receiver by design participates in the latter mode. From intercepted signals the computer forms commands for time delay, kind of modulation, power and frequency of repeater jamming to be broadcast by the transmitter, which creates a false aircraft marker on the enemy radar screen.

The ALQ-131 is housed in a pod and is also included in the authorized set of equipment for F-15 fighter aircraft.

The U.S. Air Force has been developing the PLSS integrated automated system which should permit a continuous search, detection, identification, and determination of type and coordinates of ground radars as well as guide attack aircraft (including Wild Weasel aircraft) to them with high accuracy. It is proposed to use the TR-1 high-altitude subsonic reconnaissance aircraft built on the basis of the familiar U-2R "airborne spy" in the PLSS system as an ELINT and signal relay aircraft. Three TR-1 aircraft (the air-based echelon) perform radio intercept from duty zones with on-board equipment and transmit data to a ground control center, where precise coordinates of radars which have begun operation are determined by the triangulation method. The

high flight altitude (15-20 km) of the TR-1 aircraft allows extending the reconnaissance information field up to 200 km into enemy territory.

Replacement of the F-4G Phantom aircraft by the more advanced F-16 Wild Weasel aircraft also is expected. Foreign specialists include among the latter's advantages the almost two times less radar cross section (providing better radar camouflage of the flight) as well as the lesser thermal emission level, leading to a decrease in the aircraft's vulnerability in the system coverage of low-altitude missile systems with IR guidance or from the threat of attack by an interceptor equipped with short-range heat-seaking missiles. The higher maneuverability of the F-16 aircraft also is considered a positive factor. A new receiver with antennas located in pods fastened to the panels in place of Sidewinder air-to-air missiles (provides for 360 degree intercept of signals) will be used in the system which warns that the aircraft is being irradiated. ECM equipment is accommodated in pods suspended beneath the fuselage.

And so efforts of the Wild Weasel system's creators are aimed basically at reducing aircraft vulnerability. The possibility of using drones (BPLA) to combat surface-to-air weapons of air defense is being examined in this plane.

It is common knowledge that drones already have been used under combat conditions as reconnaissance craft and target designators. Within the framework of the new mission the search should end not simply with the transmission of data to a control point, but with an attack on the detected target. The United States has developed the small Pave Tiger expendable drone for destroying electronic emitters which are part of surface-to-air and artillery systems. Its airframe (weight 115 kg(f), length 2.13 m, wingspan 2.59 m) is made of composition materials, which provides a low level of reflection of radar signals. The ground launch complex includes a device holding 15 launch containers with one drone (wings folded) in each, power generators and guide rail. After the launch signal is given the drone moves out along the rail, the wing straightens and the solid-propellent booster starts. It makes the flight to the given area on its own according to the programmed route at a speed of 185 km/hr. When the drone enters the radar illumination zone the passive heads turns in the radar's direction and homing occurs. The Pave Tiger has no communications with the control point. With fuel consumption of the piston engine with four-bladed propeller of 3.9 liters per hour, there is enough fuel for 8-10 hours of flight. According to the American press, if a lot of 2,000 is made the cost of one series-produced expendable drone will be around $50,000.

(To be concluded.)

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